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ABSTRACT

The booklet discusses questions related to teaching engendered by the creation/evolution controversy, presents current positions of educators and textbooks, and recommends a two-model teaching approach. It is divided into six chapters. Chapter I defines and summarizes evolution and creationism as different belief structures, and outlines various theories relating to each from historical and current perspectives. Chapter II reviews the theory of evolution and examines some of the arguments criticizing it. Chapter III discusses ways people know about ideas or concepts, such as through an authority, faith, intuition, experience, and scientific method. Chapter IV examines educational issues in the creation/evolution controversy, including the legal aspects, the difference between fair presentation and indoctrination, parental concerns, and opposition to teaching both subjects. It presents arguments for and against both sides, as well as assumptions and controversies surrounding each issue. Chapter V attempts to answer the question, "Should we teach both creation and evolution in the schools?" It summarizes views of educational organizations, describes a two-model teaching approach, and outlines current attempts in textbooks to present a balanced version of the controversy and to emphasize both topics as theory, not scientific fact. Chapter VI states that teachers have a responsibility to present accurately all sides of a controversial issue. It recommends using the two-model teaching approach and emphasizing that there is much controversy and are many differing opinions. (CK)

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Teaching About the Creation/Evolution Controversy

By Jerry Bergman

Fastback 134

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Introduction

At one time or another most persons of normal intelligence have wondered about the source of man's existence. Where did man come from and how did he come into being? What caused the universe to come into existence; what accounts for the scheme of things we see in the universe? These questions have been asked since the beginning of recorded time, but in spite of the efforts of many gifted thinkers, final answers have eluded us. Although there is a wide variety of answers, there is wide disparity among them. These questions are not the subject of this fastback. Rather, it will deal with the issue of whether we should openly discuss the question of existence in the classroom. And if this issue should be dealt with in the classroom, which views should be presented? This fastback, then, is especially concerned with the questions engendered by the creation/evolution controversy.

That the creation/evolution issue is alive and important to scientists and students alike is evidenced by the fact that in 1975 alone over 60 colleges and universities hosted creation lectures or creation/evolution debates. A number of active student groups have been formed at universities throughout the country researching the question of origins. For example, at the University of California-Los Angeles there is the Evolution Inquiry Association; at the University of Texas-El Paso, the student chapter of the Creation Research Society; at the University of California-Santa Barbara, the Creation Society of Santa Barbara; and at the University of Kansas, the Creationist Club. An organization called Students for Origins Research was recently formed at Santa Barbara to coordinate activities on various campuses. It publishes a newsletter and a number of other publications written primarily by students.

Evolution and Creationism as Different Belief Structures

Essentially, *evolution* is the belief that all living things descended from a few simple forms of life or from a single form of life that has progressed from a simple to many complex forms. *Creationism* is generally defined as the belief that all living things were created by an outside agency basically as they now exist. In addition, creationism supports the premise that there is purpose and order in the universe in both living and nonliving things, whereas evolution sees purpose and order only as man defines it. Creationism generally opposes the idea that chance is an important factor in the order of things and instead stresses order and purpose.

Evolution is generally divided into two types. The first, called *materialistic or atheistic evolution*, is the belief that the changes in the world result from the operation of the inherent potentialities of living and nonliving things that are not subject to control or intervention by any supernatural power. The second type, *theistic evolution*, implies that a god or God began the whole process by originally creating matter and life and continues to direct the changes that eventually evolved into the universe as we now know it. This form is by far the most generally accepted and popular viewpoint and in many ways is closer to creationism than atheistic evolution. Theistic evolutionism differs from creationism primarily in the amount of outside intervention considered necessary to account for the existence of the universe. A theistic evolutionist would accept the present scheme of things as a result of both pre-existing natural laws and chance.

Creationist beliefs also cover a wide spectrum. *Progressive creationists*, for all practical purposes, are very close to the theistic evolution stance in their belief that a series of creations is responsible for the

many forms of life in the universe. This interpretation is used to explain the gross gaps in fossil groups in the geological timetable.

Another type of creationist belief is called *divine fiat creationism*—the belief that the universe and all that is in it is the result of a direct instantaneous creative act by an outside power, i.e., God. Most creationists concede that some variations or changes have occurred but that those changes can be better explained by biological research than by theology. It must be stressed, though, that the lines between creationists and evolutionists are obscured by a number of different viewpoints.

The main argument of creationists is that all the artifacts of human existence come about only through the direction of an intelligent designer. Likewise, they reason that the natural world, as complex as it is, must have had an intelligent designer. Further, they stress that organisms are much more complex than any machine and therefore presumably require more design and direction. Thus, by extension, the designer of human, animal, and plant organisms would have to be more intelligent, more powerful, and more knowledgeable than man. There are many other arguments used, such as the second law of thermodynamics, but the argument by design tends to be one of the more popularly accepted ones.

The analogy of design, however, does not "prove" creation. The reasoning used to prove the existence of an intelligent creator, or that the cosmos could not have come about by chance is, of course, open to debate. It is logical to argue that the act of creation demands a creator with intelligence, and intelligence can reside only in a personality; therefore, the creator must be a person and that person must be God. However, the validity of this proof depends on what one demands as sufficient proof. Such reasoning could not be verified by the empirical method, for example, and thus is open to debate.

In many ways the theistic evolution position combines the best of both beliefs. Nevertheless, the theistic evolutionist must contend with the many problems in evolutionary theory and many philosophical objections to the assumption that some outside force is needed to account for present-day existence.

On the basis of increased scholarship, the modern creationist move-

ment seems to be developing a fairly well-defined set of beliefs. This movement cuts across a number of groups that sometimes are hostile toward each other. In some ways, it has taken on many of the characteristics of the Darwinian movement of the nineteenth century when philosophical differences were forgotten and odd bedfellows worked together. Although the movement is colored by preconceived ideas (as are all movements), as a whole, it seems to be open to growth from the results of sound scholarship. Even the conservative creationist position acknowledges that a certain degree of modification of living forms occurred in the past. This modification, though, is within clear limits.

It is sometimes assumed that the Christian church historically has held a creationist position similar to that identified with fundamentalist, evangelical Christians today. Actually many early Christians, including some of the most prominent church fathers such as Origen, Clement, Plotinus, Gregory of Nyssa, and Augustine, among others, held views that were in many ways very similar to the evolutionist view, and believed Genesis to be a highly symbolic allegory. It is true that during certain periods there was a very strong belief in the literal interpretation of Genesis, but this was by no means true throughout the history of the church, nor was this view always in a majority among early church scholars. Historically, many of those who interpreted Genesis literally at the same time accepted the concept of spontaneous generation, including one of the most well-known early literalists, Basil the Great.

Likewise, Hooykaas points out that the notion that Christianity has opposed science throughout history is false. The very early church fathers were cognizant of Greek philosophy and science and were eager to assimilate much of it into the general framework of Christian theology. Augustine warned: "We must be on our guard against giving interpretations (of Scripture) which are hazardous or opposed to science and so exposing the Word of God to the ridicule of unbelievers."

From a modern day perspective we can see that early Christian writers were perhaps too eager to incorporate Greek speculation into their theological framework; for example, the ancient belief that the stars were small gods or a type of coded communication system whereby God could communicate with man.

According to Robert Clark, a review of the history of science and religion reveals that, although the common people refused to accept new scientific ideas, the clergy often were very receptive to scientific research. However, it should be pointed out that their "science" often included what we today know to be pseudoscientific or erroneous ideas, including alchemy, astrology, extreme catastrophism, phrenology, spontaneous regeneration, and bloodletting, to name a few. Contemporary Christian apologists often refer to the fact that both the Hebrew and the Greek scriptures rarely allude to many of the fanciful beliefs commonly shared by the people living at the time the scriptures were written.

It is commonly assumed that the ancients believed in a mass of myths that we with our scientific enlightenment have dismissed. While there are many ancient beliefs that we would recognize as foolish, as a whole, the ancients had many beliefs remarkably similar to our own. Notable among these ancients are Greek writers such as Theophrastus, Lucretius, and Galien. For example, the view that the center of the solar system is the sun, around which the spherical earth revolved, was discussed by Aristocras of Samos in 280 B.C. Many ancient philosophers were agnostic or atheistic and believed that a totally naturalistic interpretation could explain both the universe and everything in it.

The view that an outside force is necessary to produce a unified complex universe is less tenable today than ever before in history because of today's scientific knowledge. However, because science has revealed the universe (and especially the biological world) to be far more complicated than the simplistic notions of the ancients, it could be persuasively argued that such complexity has to be the result of some outside force or design.

Unquestionably there has been a tremendous increase in the amount of knowledge, but in many ways the viewpoints of the ancients on many things have not changed drastically but merely expanded as the world has been found to be much more complex than previously thought. If this process were to continue 2,000 years hence, civilization may look upon this generation as frightfully backward, much as we look upon ancient civilization as naively primitive in some respects.

Explanation and Critique of the Theory of Evolution

It will be helpful at this time to review the theory of evolution and to examine some of the arguments criticizing it. The theory of evolution includes the following ideas:

1. All living organisms reproduce so as to increase in numbers at a geometric rate. Reproduction by cell division illustrates this geometric rate of increase. One amoeba divides to form two amoebas, each of which will divide again, forming a total of four amoebas. The next division will give eight, the next 16, etc.

2. For each generation there is a tendency for the number of members in each population to remain somewhat constant. Thus a large number do not survive.

3. The most fit, the strongest, or otherwise most adapted are more likely to survive. This assumes that there are variations within each population gene pool. It also assumes that the variations can be passed on to offspring and that some variations offer a clear survival advantage, i.e., greater reproductive success.

4. In time, a new species will evolve. This process is slow and involves the accumulation of changes in gene frequencies in the gene pool of a large population. Further, the changes must provide the organism some survival advantage. In time, because of the gene changes, the organism survives the competition and increases its numbers within the population. Eventually, the entire population or most of the population will have the characteristics that are advantageous to survival. Again, within this new population other variations will occur. If one of these variations gives the organism a survival advantage, it will likely endure and eventually spread throughout the popu-

lation, causing a second change within the population. This process continues, moving the organism on to a better adaptation each time.

Creationists criticize the above theory on a number of grounds, among them the following:

1. Changes in temperature, climate, or other environmental variations, they feel, cannot account for the development of unified, complex body structures such as the ear or eye.

2. Micro or small changes are unable to account for complex structures such as the eye which, in terms of function, is useless until completely developed. There is no clear example in the living world of organisms that shows the process of evolving to a major degree (mega evolution). Animals that have "simple" eyes are as fully developed and as fully functional as animals with complex eyes. The organs of each animal seem to be fully developed and suited to the animal's needs. Although there is a tremendous variety, for example, in the types of eyes animals have, this in itself does not prove they evolved from the simplest to the most complex, but only that existing eyes can be ranked from the simplest to the most complex.

To some degree, evolution is a glorification of the complex. Actually, in many ways the simpler organisms are superior in that geologically they have survived the longest. It could be argued that the simplest design is more advantageous as it is less likely to break down. In mechanics, simpler machines that do the same job as more complex machines are generally better. They have fewer moving parts and therefore less can go wrong. A simpler organism is likewise superior if it is able to carry on all the functions of more complex organisms since it has the advantage that there is less to break down or go wrong.

3. Another argument creationists use is that variations in species can be accounted for by the existing genetic structure. The environment may cause a change in gene frequencies, but recessive genes are always present in the organism's total gene pool. An example often cited in textbooks is the peppered moth in England. This moth apparently has adapted to the changing atmospheric conditions in England. When there was little industrial pollution, the bark of the trees surrounding factories maintained their natural light color. Thus the light peppered moths dominated because the darker moths that

perched on the light-colored bark were more visible to predators. With the advent of the industrial use of coal and its resulting heavy pollution, the tree trunks became darker. In time, the dark moths became predominant because the light moths were more visible. At present, with the discontinuance of coal furnaces and lower levels of pollution, the light-colored moths are reported to be increasing in numbers. Although evolutionists commonly use this as a prime example of evolution, creationists argue that this example only shows that changes in environment can change the frequency of certain phenotypes. The species of moth contains the genes for both white and dark colors, and which color predominates depends on the environment. Creationists feel this is not a change in the moth itself, i.e., the moths are still moths and both colors still are around, but simply a change in gene frequency.

There are many other problems that creationists find with the evolutionary theory, many of which are readily acknowledged by evolutionists.

4. One of the creationists' strongest points is their argument of design. Design is the concept that the physical and natural world is the result of deliberate direction much as a machine is the result of deliberate planning and execution by trained men. To understand the function of a machine one must ask, What is the purpose or function of each part? Thus, to understand the natural world and its parts, one must look for design and purpose. Creationists argue that a maximum degree of design currently exists in most organisms. It would be difficult to improve drastically upon the design of an organism without drastically changing the function of the organism and the so-called balance of nature. Creationists commonly point to the many attempts by man to change the environment that have resulted in a number of serious problems arising from a lack of knowledge about the environment. This common occurrence is summed up in the maxim "nature knows best."

The science devoted to a study of the balance of nature is known as ecology. Understanding the so-called balance of nature is necessary so that man's attempted improvements do not cause further problems. Through selective breeding man has produced animals more suited to

his own purpose, but it would be difficult for him to develop a more efficient eye than that which already exists in a cat, for example. Creationists argue that the natural world exists as a result of intelligent design that has its origin outside of the natural world. This is probably the most controversial aspect of the creation model, because many feel this assumption requires an interpretation that goes beyond the data. Creationists, though, point out that evolution likewise requires interpretation beyond the data and insist that some "outside force" called natural laws or some type of syntropy is necessary to explain the order in the universe. Syntropy is defined as an "inner force" in living things that propels them to higher levels of development.

Evolutionists challenge the creationists' argument that some outside force designed and produced the natural world by asking the question, Who designed and produced this outside force? This same problem, however, is faced by evolutionists who are unable to answer such questions as, Where did the matter of which the universe is made originate? or, Why can we abstract laws and order from the universe, i.e., why does gravity always work, why does light travel at the same speed (depending only upon what it is traveling through) and why does centrifugal force work? We believe that these laws always work, and there may not be exceptions, but, nonetheless, there is no reason for these laws always to operate.

As "faith" is used to bridge the gaps between empirical evidence and the creationist theory, likewise a "faith" is used to bridge corresponding gaps in the evolutionary theory. Creationists have difficulty proving the assumption that creation requires a creator, and likewise, evolutionists have difficulty proving their basic two assumptions, namely: 1) there is order in the universe, and 2) this order is knowable to man. Both of these assumptions have as much support as any law of science, but are still assumptions that cannot be "proven" absolutely.

The creation/evolution controversy is ultimately reduced to the question of "how," which is intrinsically bound up with the question of "who." Whether or not there is a "who" clearly affects the "how." Joseph Ciparick expresses this in another way when he states, "Science has no room for an outside power premise, but sometimes it does

propose similar 'forces' that are 'unknown' and possible missing links."

A theory is tentative principles offered to explain observed phenomena. A theory is, by definition, speculative and expendable. A theory does not have to be proved to be useful. What is required of a theory is that it be relevant to facts and be capable of generating testable hypotheses. A theory should be more than a wild guess, but even good theories that are based on empirical observation are merely promising ideas in need of more supportive evidence.

The evolutionary theory, of course, is based on a tremendous amount of research evidence, both empirical observations and logical speculation. Yet, care must be exercised in accepting and defending as gospel what ought to be regarded as an expendable hypothesis.

Ways of Knowing

An important question concerning the validity of any field of knowledge is "How do we know what we know?" There are several ways to approach this question.

1. *Authority.* Authority refers to reliance upon those people who have become known as authorities in a certain area. We cannot know everything about everything or even most things about one area. Thus we need authorities. However, eminent authorities disagree among themselves, and their viewpoints are not uncommonly wrong. There is no way of guaranteeing the correctness of information from any authority. In many situations, such as the decision about the advisability of a surgical operation, we have little choice but to rely on authorities.

2. *Tradition.* Tradition is in many ways one of the most reassuring ways of knowing. Many define tradition as the accumulated wisdom of all ages. However, tradition has accumulated a lot of foolish ideas. Many traditional beliefs are simply wrong, including the belief that colds are caused by wet feet, that one's character shows in one's face, and that geniuses are often delicate, impractical, unstable, and unsuccessful people.

3. *Faith.* Still another way of knowing is faith. Faith is simply what people believe or feel is true. A simple illustration of this is the proposition: I have faith that the person I assume is my mother is, in fact, my mother. I have no proof of this and probably do not have any reason to try to obtain proof, but I simply accept this on faith. Nothing has given me a reason to doubt this but it is, nonetheless, a belief accepted on faith.

A scientist likewise operates on faith in many instances. For example, he has no firsthand experience with much of what he reads in scientific journals, i.e., he did not do the experiment and thus has to trust the researchers who published the material in the journal. If the research has been replicated a number of times, the scientist will tend to believe (or will have faith) that the information is valid. Nonetheless, to some degree, without firsthand replication of the research results, he is forced to rely on his faith or belief. Many evolutionists have never seen firsthand the unearthing of a woolly mammoth, yet few doubt that woolly mammoths existed, nor do many doubt that the bones that are now in museums were in fact dug up by scientists. Yet their acceptance of the discovery of woolly mammoths is still based on faith or belief.

4. *Intuition.* Intuition is any insight, whether true or false, whose source the receiver cannot fully identify or explain. Many of us have hunches about certain events and not uncommonly we are right. Actually, intuition has a source, namely experiences and information we cannot fully recall. Students may intuitively recognize an answer on a test, for example, and not know exactly why they selected the answer they did, but they just "felt" the answer was right. Undoubtedly in such situations we are relying on unconscious information that we previously learned. Unfortunately, with intuition, we are often wrong even though we may feel quite certain about the information or idea.

5. *Experience.* Experience, in many ways, is one of the more reliable ways of learning. Experience is the basis for much of our intelligent behavior. From our experiences, for example, we learn the fastest way of driving from our home to work. In trying to determine which route to work is fastest, one could calculate the average distance or time to travel each of three or four possible routes. From this average one can determine which route is the quickest. A handicap of this approach is that some of us simply do not learn from our experiences. We are not careful observers and thus assume a way is best when it is not. Further, there are unquestionably many possible explanations of which we have not thought. For example, in determining which filament is best for a lightbulb, there are thousands of different possibilities; or there are situations in which an idea could be totally thrown

out and replaced with another idea, e.g., using neon bulbs in place of filament light bulbs.

6. *The Scientific Method.* The method of acquiring knowledge that most educated people would consider the most effective is the scientific method. Actually there is not *one* scientific method, but several. In general they involve a series of steps in the following sequence:

- a. Identifying the problem. There must be a determination of a problem in order to ask the right questions. The skills of observation are needed to formulate all possible questions that need to be answered.
- b. Listing possible hypotheses to explain the problem.
- c. Testing the possible hypotheses to determine which one is the most effective.
- d. Verifying evidence. Observation alone is not science, but observations that any other observers can see, weigh, measure, or check are essential in the scientific method. To be science, research has to be replicable; e.g., if I say that mixing two parts of hydrogen and one part of oxygen together makes water, anyone can replicate or repeat the experiment to verify it.

Science endeavors to describe reality and concerns itself primarily with objective, empirical reality as perceived by the senses and measured by precise instruments. Science does not concern itself with such things as purpose or duty, but only with describing objective reality. Science stresses measurement with the assumption that if something exists, it exists in some amount, and if it exists in some amount, it can be measured. Measurement is one of the primary tools of scientists. In addition, scientists describe reality abstractly in the form of laws that give order to the universe.

One of the most common ways of determining truth in science is through the controlled experiment approach. For example, two groups of people or animals are selected and measured or tested to make sure they are similar (called selecting the sample). Then on one of the groups (experimental) a treatment or experiment is administered. The other group (control) is treated as nearly as possible like the experimental group, except for the experimental factor that is being tested. Finally, both groups are compared to see if the experi-

mental factor has made any difference. By this method we can determine the effects of the experimental factor. This method is called the pre-post-test experimental design.

Because of the nature of some fields of study, they cannot be verified by the scientific method. This includes history because a historical event is not replicable. We cannot repeat, for example, World War II to see how it would have progressed if Adolf Hitler had never been born. We cannot now have a pre- and posttest group in studying any aspect of World War II. We can only study several wars and from those deduce certain principles of behavior.

Thus the heart of the scientific method is the problem/hypothesis/test process, but because of the very nature of the theory of evolution, it is difficult to verify evolution in this way. The key requirement of the scientific method is replicability. As G. G. Simpson notes, "The testing and correcting (in science) are done by means of observations that can be repeated with essentially the same results by a normal person's operating by the same methods and with the same approach."

At present, evolutionary, genetic, and biochemical research has not been able to 1) create life from nonlife, 2) create new organisms aside from normal genetic variations, or 3) produce what are clearly transitional forms of life or forms of life with transitional parts, e.g., an organism that is clearly between man and a lower primate, such as a rhesus monkey. Researchers have been able, through selective breeding, to develop strains of animals that are superior for specific purposes, such as producing milk or meat, but no clearly new species has been brought forth.

Joseph Ciparick notes, "Any attempt to explain the origin of things—the earth, species, man—is going to be inadequate. Unless we can go back and see what actually happened, we are all working in the realm of pure hypotheses." Since we have only indirect evidence or secondary sources of information relative to what happened, origins can only be inferred; but this is not science in a strict sense. Science requires replicability, which cannot be satisfied in the case of historical evolution. To repeat evolution from amoeba to man in the laboratory is an impossibility. We can, on the other hand, extrapolate from what is seen in the present to the past and possibly quite accurately, but, in

the strictest sense, this is still not science. As Ciparick comments, "The creationists make some valid points when they say that the evolutionists are not strictly 'scientific' in their presentation. True, the actual appearance of a new species evolving from another species cannot be duplicated at this time. There is a lot of circumstantial evidence—very impressive evidence—but we still have to resort to our imagination for an 'ultimate' explanation."

Much that falls under the rubric of evolution is actually in the same category as history. One theory may fit the facts more than another theory, but this does not argue for presenting only one theory.

Much of evolutionary science involves examination of the present world and extrapolation from this world to the past world. For example, the use of carbon 14 dating methods requires first of all the determination of the rate of carbon 14 decay (i.e., the determination of the half-life). Then the carbon 14 content of the sample to be dated is measured. The original carbon 14 content of the sample is assumed to have been equal to the standard modern content of a living organic substance, and by knowing the rate of decay of carbon 14, it is possible to extrapolate backward to determine the time since the sample of organic substance died and ceased taking in carbon 14 from the environment. In the case of potassium-argon dating, the original amount of argon in the sample is calculated, based on certain assumptions, and the present contents are measured. With knowledge of the half-life of potassium, it is possible to extrapolate back to determine the age of the sample.

As can be seen, numerous assumptions are required for these radiometric dating methods. The original amount of carbon 14 must be assumed to be equal to the modern standard amount found in living organisms. And it must be assumed that carbon 14 neither escaped from nor was added to the sample, and that the carbon was not diluted with ordinary carbon from the environment. In the case of the potassium-argon method, it must be assumed that neither potassium nor argon were added to or subtracted from the sample. And, as always, the constancy of the radiometric decay rates must be assumed. The web of assumptions is actually more complex than described above. None of these assumptions can be measured experimentally, although some

can be supported by circumstantial evidence. Nevertheless, the fact is that no historical incident or process can be established incontrovertibly by experimentation. We can only research the present and extrapolate into the past.

Even data that can be verified by observation or experimentation does not indicate the conclusion is absolutely settled. A common preoccupation of the sciences is replication of previous experiments. Unfortunately, all too often the replication does not duplicate the original results. There are few concepts, especially in the psychological and sociological sciences, that produce fully consistent results from research. When this is the case, research results are sometimes decided in science by a "vote" of the studies. If eight studies produce positive results and three produce negative results, then the hypothesis is accepted based on the results of a majority of the studies.

All science, even mathematics, operates under certain philosophical assumptions. Robert Twiss notes,

... science does not reveal absolute truth, notwithstanding the popular misconception. Because the possible applications of a theory are infinite in number, that theory can never be proven for all situations. Thus a theory is scientifically "true" only until a violation of the theory is demonstrated. Even the most time-honored theories are not sacrosanct.

In this connection, Twiss concluded, "With this in mind, the evolutionist and creationist positions can be seen to be two equally viable approaches to the same problem taken in the context of two fundamentally different philosophical systems."

There is a tendency for most contemporary scientists to divorce so-called metaphysical reality from physical reality. There is no reason for the universe to be divided up into physical and metaphysical spheres. While the axiom in the physical sciences, "if it exists it can be measured," may be appropriate for scientific research, it does not hold that if a metaphysical phenomenon cannot be measured, it does not exist. While the religion/science dichotomy can be useful, it is artificial and can limit the progress of both religious understanding and scientific learning. Especially have we seen this conflict surface in the current creation/evolution controversy and in the field of origins studies in general. To break down this dichotomy requires looking at

sources of knowledge not only on the basis of our sensory input, but also through utilizing the powers of reasoning, analysis, etc., all of which are important sources of knowledge in the religious sphere. The resurgence of interest in the occult, extrasensory perception, and transcendental meditation are examples in which both the scientific method and traditional ways of knowing are used.

Acceptance of the idea that there could be other phenomena that are "real," aside from those that are studied by orthodox approaches to science, points to a broadening of both interest in and respect for research in the so-called metaphysical domains, even though such research has not been very promising to date. James W. Cornman points out that the methods and logic of traditional science can be applied to the so-called metaphysical area as well. Phenomena that cannot be directly perceived by human senses are not necessarily less real, nor are they necessarily less testable by the scientific method. More complex procedures and a greater understanding of the universe as a whole may be required for research in this area, for while metaphysical reality may be less obvious, it is not necessarily less real.

All valid phenomena are subjects for research and more and more scientists are giving thought to areas apart from purely physical phenomena that have been the preoccupation of science for the past century. A proper study of science requires a thorough examination of a number of assumptions. The assumption that if something can be perceived by the senses it therefore must be "real" has been questioned by many writers. This does not mean that groundless speculation is to be relied upon, but a firmly supported set of ideas can be built one upon the other, relying on logic and reasoning, as well as the results of empirical investigations.

Even within the natural world it has been found that the assumption that all matter is made up of molecules was far too simple. Molecules are made of atoms that are fairly complex entities in themselves. Atoms are made up of other particles called subatomic particles of which dozens have been discovered. Subatomic particles also are increasingly coming under scrutiny and it seems that there is no end to "breaking down" matter further and further. If molecules are made up of atoms and atoms are made up of subatomic particles, conceivably

the breakdown could continue indefinitely. This proposition is difficult to comprehend and is not unlike the idea that matter has always existed or that God has no beginning.

This discussion and critique of ways of knowing does not mean we always need to question every statement or theory, but we do need to look at our sources of knowledge and how we have arrived at what we believe to be true. All ideas have certain probabilities of being true and looking at how something is known helps us assess the probability of its validity. For this reason there is a need for a good integrating science text that will describe the various approaches that have been tried in attempting to solve the mystery of existence. The various approaches are not mutually exclusive. A God hypothesis does not exclude a naturalistic explanation of how God works. A no-God hypothesis does not rule out some sort of power that we cannot define. The problem arises when the God people try to tell us exactly what God is like (as a final, definitive presentation), or when the nature people say they have found the definitive explanation. The problems are many, but the problems should be presented with the hope that both sides may learn and understand.

Educational Issues in the Creation/Evolution Controversy

If schools are truly to be places of inquiry, we must not inhibit investigations in any single area but must look at all sides of all issues, even issues some people label "religious." As McMahon has stated,

Since meaningful religious questions are largely irresolvable and do not lend themselves to resolution through controlled inquiry and systematic explanation, why should they play a significant role in class discussions? One reason is clearly pedagogical—students are interested in religious issues and interest is a powerful vehicle for learning.

In other words, because answers are difficult to come by in philosophical and value areas, this alone is a good reason why they should be included in the classroom. McMahon goes on to say, "Five years of English teaching convinced me that few topics were capable of garnering the rapt, almost eerie attention that accompanied interchanges relating to such subjects as the origin of existence, the source of moral guidance, the meaning of life, and the existence of God."

John T. Scopes, the young biology teacher from Tennessee who was brought to trial in 1925 for teaching the theory of evolution, stated in 1969, "this country must not rest with the overturning of the 'monkey law'. . . . our personal freedom and liberties are never laid to rest because if individuals are not constantly aware of the dangers and pitfalls in the past to maintain liberties, they become complacent, and will lose every one of them." Probably few creationists actually want to forbid

teaching evolution. Their main concern is that evolution be taught as a theory and not as fact, and that creation theory be at least discussed and presented accurately. And creationists argue for this goal on the same grounds that Scopes argued for the freedom to teach evolution. This freedom is not always granted to those teachers who want to teach creationism.

According to most legal opinions, it is not against the law to teach the creation model. Wendell R. Bird comments,

Neutralization by means of instruction in scientific creationism also would not necessarily have a legislative purpose of furthering religious rather than secular concerns that would contravene the establishment cause. . . . similarly, addition of scientific creationism to a biology course that exclusively teaches the general theory [of evolution] has the secular legislative purpose of presenting more than one non-religious explanation of the origin of the world and life. Even the agnostic Clarence Darrow [in reference to the Scopes trial] remarked that it is "bigotry for public schools to teach only one theory of origins."

Even if various theories of creationism are defined as religion constitutionally, creationism can be taught within the public schools if taught objectively. This was affirmed by the U.S. Supreme Court in the *Schempp* decision in 1963, which banned state-imposed devotional exercises but upheld the objective study of religion. (See Phi Delta Kappa's Fastback 123, *Church-State Issues in Education*.) One attorney's opinion of this is, "The implication is that the Court in *Schempp* places an affirmative duty upon the public schools to teach religion 'objectively.' If, however, the State schools fail to fulfill their duty to teach religion 'objectively' then they are being 'hostile' to religion. Thereby, they violate the students' freedom of religion."

Actually, laws still exist in some states that are more antagonistic to evolution than creation. It was not until March 1967 that the Tennessee State Senate voted to amend the law that led to the famous Scopes trial over 40 years earlier. The amendment stated, "Teachers could refer to evolution, but only as a theory and they must maintain that God's creation is a fact consistent with the 'Good Book.'" In Mississippi it is still against the law to teach evolution. In January 1970, a bill to repeal Mississippi's ban on teaching evolution was defeated by a 70 to 42 vote in the State House of Representatives.

Why not teach about religion in the public schools as any other subject is taught? All academic fields are worthy of consideration in the curriculum and why exclude one field, even if it is controversial?

The main objection to teaching about religion in the schools is that there will be attempts by teachers to indoctrinate students. This, though, can occur in most any field. In political science or sociology courses teachers can and do use their influence to indoctrinate students in the teachers' own economic or social theories. It is not unknown for teachers to teach theories of racial superiority in their classes. In a school in which the writer taught in the late Sixties, several teachers in a so-called drug education program actually openly encouraged the students to use some types of illegal drugs. The position of these teachers was that smoking marijuana is harmless to your health, and no one should prevent someone else from smoking it. This was the teachers' opinion, and they were supported by their principal in the name of academic freedom.

Our concern should be not with indoctrinating students regarding *religious* ideas, but with indoctrinating them regarding *any* ideas. Teachers should be concerned with honestly and fairly presenting material in *all* subjects, and not indoctrinating students in *any* subject.

The fact is, it is impossible not to teach about religion in the schools. Even by scrupulously avoiding all references to religion, religious beliefs, and religious events, one is teaching something very definite about religion, i.e., it is not important, it has had a negligible influence on society both historically and currently, and that to some degree it is not necessary. If students spend 12 years learning history, science, sociology, psychology, and geography and rarely encounter religious beliefs, happenings, events, and ideas, they will probably develop very definite conclusions—essentially that religion is not important.

Religious ideas have been extremely important in the development of Western civilization—its values, culture, and social institutions. Religion has played an important part in the wars, governments, economic systems, and most other aspects of society. Any proper understanding of history should include a discussion of religion. Both the

positive and the negative influences should be brought out, hopefully in a balanced way. This may be a difficult goal, but at least attempts should be made to approach this ideal. With the current emphasis on moral education, values clarification, and death education, religious values are bound to be brought up and discussed more often in school than they have been in the recent past.

There are several indications that parental concern is increasing regarding science courses that teach evolution as fact. A number of surveys of college students, parents, and citizens in general found that the majority of persons desired that both evolution and creation be taught in the public schools. For example, in 1973 the Del Norte County Unified School District in California conducted a random survey of 1,346 homes, asking "Should evolution be taught in public schools?" Fifty-eight percent answered yes, 34% answered no, and 3% were undecided. In the Cupertino Union School District in California a random survey of 1,995 homes found that in answer to the question, "Should scientific evidence for creationism be presented along with evolution?" 84.3% answered yes, 7.8% said no, 6.3% were undecided, and 1.6% answered neither.

The opposition to the teaching of creationism in the school was summarized by William B. Mayer in the *Newsletter of the Biological Science Curriculum Study Committee*, November 1972. Mayer argued that the reason creation should not be taught in the schools is that it is not science because it cannot be proven by observation or experimentation. If the natural world came into being by an act of special creation in the past, this cannot be duplicated. Thus it cannot be proved that it happened since there were no observers of the supposed "original" creation.

This same argument, though, can be used against the teaching of evolution as well. It is generally assumed in evolution theory that originally spontaneous generation took place under conditions that no longer exist today. It happened at one time, but cannot happen today unless scientists are able to duplicate what they assume were the original conditions. Further, it is theorized that evolution took place under conditions that were different from those today. What these conditions were cannot be specified. Except for variations in such fac-

tors as temperature, radiation, and climate, it is difficult to hypothesize what factors could create an environment that would produce the first forms of life. The hypothesis, though, is that the conditions must have been greatly different for life to originate naturally, because somehow it did. The natural world exists and there must be some explanation to account for its existence. Therefore, it is only a question of finding the most reasonable explanation.

Often it is assumed that the creation/evolution controversy is one between those involved in religion on the creationist side and those who are either neutral or negative toward religion on the evolutionary side. By and large, this is not true. Ashley Montague, the noted anthropologist, stated, "In fact, many contributions have been made to the understanding of organic evolution by men who were profoundly committed to both religion and science. Much of our knowledge of fossil man in Europe, where more is known of fossil man than any other region in the world, has been a direct contribution of Roman Catholic priests supported by their church in their prehistoric research."

The assumption that religious people agree with the creationist position and that evolutionists are atheistic is clearly incorrect. When the Dallas School Board voted 6 to 3 in 1977 to approve the use of a biology textbook that discussed creationism in a favorable light and tended to be critical of evolution, a number of local clergymen responded by opposing the adoption of this biology text. In one creation/evolution controversy in California, supporters of both the creation and of the evolution side turned out in large numbers for a board hearing on the subject. An impressive array of scientists supported the pro-creation side, while the science faction mustered many theologians to its defense. The assistant superintendent of Sacramento Catholic schools, Rev. James F. Church, argued against the inclusion of the creation theory in science texts, while a number of scientists strongly supported the teachings of creationism in the schools, at least as a viable alternative. It is difficult to say specifically what percent of each persuasion supports the creation or the evolution side, but it is clear that a number of secular scientists support the

creationist side and a number of individuals whose main profession is in theology support the evolutionist side.

The creationist position in the California controversy was summarized by one participant: "I . . . resent the evolutionary presentation being thrust upon our children without even a hint that there are at least some qualified scientists who believe in creationism. And immediate steps should be taken to stop the ridiculing of the creationist point of view by seeing that there is a balanced presentation in all schools."

At the National Association of Biology Teachers convention in San Francisco in October 1972, the noted biologist Theodosius Dobzhansky, addressing a capacity audience said, "I believe with Teilhard de Chardin that evolution is God's method of creation." Even Darwin himself said,

. . . authors of the highest eminence seem to be fully satisfied with the view that each species has been independently created. To my mind it [the existence of nature] accords better with what we know of the laws impressed on matter by the Creator. . . . There is grandeur in this view [evolution] of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone circling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been and are being evolved. (*Origin of Species*, p. 483-485, Collier Edition)

Should We Teach Both Creation and Evolution in the Schools?

One conversant with the literature on both creation and evolution finds there are shortcomings in both theories. The creationists tend to bridge problems with "faith." Scientists may not question the basic evolutionary hypothesis, but many aspects of the theory are currently being debated. Some of these debates should be brought out in the classroom. When discussing the evolution theory the various hypotheses should be brought forth for no other reason than to help students understand that there are many aspects of the theory (as with most all theories) that are debatable.

The history of the theory of evolution reveals that evolution has been forced to undergo a number of changes (as have theories of creationism) and will no doubt continue to undergo changes. For example, Darwin hypothesized the theory of pangenesis, or hypothetical tiny particles that were assumed to accumulate from all parts of the body in the germ cells (the egg and sperm). Darwin believed that outside variations caused the body to modify and that the pangenesis somehow picked these variations up, stored the new data, and passed it onto the animal's offspring. This idea is very close to the Lamarckian doctrine of hereditary transmission of acquired characteristics. Today it is recognized that this theory is incorrect, but yet it was a key element in Darwin's hypothesis. In time, this and other aspects of the original Darwinian theory were modified into Neo-Darwinism partly as a re-

sult of the work of Morgan and others in genetics. In time Neo-Darwinism was modified with newer theories.

The creation/evolution controversy touches on one's fundamental philosophy of life. The problem, as stated by Joseph Ciparick, "involves attitudes and dogmatic positions on both sides, as well as philosophical points of view. Evolution-creation both are theories, both are myths, both are models." The essential point is that we must honestly deal with differing points of view, regardless of our own, and regardless of the prevailing point of view. Because a small number of people accept a point of view does not necessarily make it either correct or incorrect. Our concern is, should students be aware of, or at least exposed to, differing points of view, *even if* they are held by a minority? The limitations of time may force a teacher to spend less time on some theories, but even if there are a number of opposing minority theories, some exposure should be given to each.

In teaching it is important that ideas not be forced on the student. Many concepts in science can be supported by a tremendous amount of evidence and are accepted by virtually all researchers in the field, but nonetheless, they are still ideas and can be wrong. Establishing teacher credibility requires presenting material in nondogmatic ways according to the merits of the facts. Ideally, the evidence, both pro and con, should be presented for both sides. Information presented in a forceful, logical, coherent manner will be accepted by students. On the other hand, when information is forced on a student, the student either reacts against it or accepts it without full understanding. Information presented in a dogmatic way is learned without any strong foundation. In essence the student has learned *what* but not *why*.

As Ciparick has stated, "[O]ne very important aspect of a true education is that the student has a feel for the open-ended explanation." A problem that is solved stops thought, but a problem that does not have a clear solution often elicits thought and later research until some confidence—or at least more confidence—in the answer is attained. All too often we assume an area is understood and that there is nothing else to be learned. Then some doubter opens up a door that leads us to a whole new area of research. Newton's laws of motion and the principle that matter and energy cannot be created or destroyed

were held to be solid, irrefutable laws of the universe for decades until Einstein postulated that matter and energy can be transformed, as illustrated by his famous equation $E=MC^2$. Study of a number of models, myths, and theories will broaden the student's point of view and enable him to be more tolerant of other world views. Probably the strongest argument for questioning even the most firmly held idea is the fact that in many cases the process of questioning fires the imagination, leading to important discoveries.

The Views of Educational Organizations on the Creation/Evolution Issue

Robert Carleton, executive secretary of the National Science Teacher's Association, states:

Most—if not all—scientists and science teachers consider the creationist theory a belief and recognize that it is a very powerful view and has a rightful place in human history and philosophy. It has its role in the education of children, and certainly no one should be deprived of an opportunity to know of this belief, to discuss it, and to accept or reject it. There are many places in the total educational process (which includes homes, church, and school) where this kind of discussion is appropriate. . . . (*The Science Teacher*, January 1973).

The National Science Teacher's Association, at this point, has not adopted an official statement relating to the inclusion in science curricula of creation by design, evolution, or other theories of the origins of the universe and man.

A number of other organizations have encouraged teachers to look at several theories of origins instead of restricting discussion to the theory of evolution. For example, the Columbus, Ohio, school board passed a resolution encouraging teachers to teach creationism along with evolution in discussions that deal with the origin of life. In 1970 the Texas State Textbook Commission, in an effort to present several theories of origins, refused to authorize the purchase of several biology textbooks because of their bias in favor of evolution. In addition the states of Florida, Oklahoma, Missouri, West Virginia, Delaware, Georgia, Alabama, North Carolina, South Carolina, Minnesota, and California all have endeavored, some successfully, others unsuccess-

fully, to pass bills requiring the legislatures or state boards of education to reduce the exclusive discussion of evolution theory in the schools and increase the discussion of other theories. All these efforts are attempts to provide, in one way or another, for equal time in the public schools for points of view other than evolution when considering the questions of the origin and development of life, particularly as they relate to man.

Harold Clark summarizes the problem as follows:

If evolution could be proved, of course it should be taught. If creation could be proved, certainly it should be taught. But since neither can be proved, and there are millions of people who believe in evolution and millions in creation, both should be taught, and the pupils allowed to take their choice as to which [to them] seems the most reasonable. But it is manifestly unfair to teach only one side of the question.

There are presently dozens of scholarly books written by evolutionists questioning virtually every aspect of the evolution theory. Biologists conversant with the field are aware of these criticisms, but the average biology teacher probably is not. Scientists have been critical of the theory of evolution since the publication of Darwin's *Origin of Species* in 1859, and today is no exception. A summary of some of the criticism was published by the Wistar Institute in 1967 in a symposium titled *Mathematical Challenges to the Neo-Darwinian Interpretation of Evolution*. Articles critical of evolution have appeared in the *Monist*, the *American Biology Teacher*, the *Atlantic Monthly*, and *Scientific Research*, among other journals. This is not to imply that the majority of biologists are questioning the evolutionary concept as a whole, but that many aspects of the theory are currently under debate. Students should be aware, for example, that the survival-of-the-fittest theory is only a minor aspect of evolution theory, and to some degree is an oversimplification.

Articles critical of the present approach to teaching evolution have appeared in scores of newspapers, magazines, and journals in the past few years. The need to discuss both sides of the issue of origins openly is well stated by McMahon: "Honest interchanges concerning the most basic assumptions about life can engender profound insight into the consciousness and behavior of others. The warm plea for tolerance

through understanding, though vital, still falls short. Differences must not only be tolerated, but valued. . . ."

McMahon goes on to argue that neutrality is actually a myth, stressing that,

... scientific neutralism is not neutral—it is a faith of a different kind. Honest religious dialogue is a rare occurrence in far too many secondary schools. . . . Hopefully, in their legitimate concern for avoiding charges of indoctrination, they will not become enamored with a medium of investigation that recognizes only the fruits of empirical verification and ignores those recesses of feeling where, on occasion, we are stunned by splendid bolts of truth. The promulgation of any single faith in the public schools of a pluralistic society is indefensible—particularly when that faith masquerades in neutral garb.

Probably the strongest pedagogical argument for teaching both theories is that it permits comparisons and contrasts. Teaching by contrasts helps the student to integrate new knowledge within the total framework of the subject. Also, by teaching with an open-ended approach where problems are not solved or "closed" and students are left on their own, students are stimulated to continue searching. As Ciparrick states, in order for science to advance, "its models and theories must be modified and even challenged if science is going to stay alive as a discipline."

The Two-Model Approach

Do students gain more understanding of scientific principles when taught from a two-model approach of origins (evolution and creation) or a one-model approach (only evolution or only creation)? In his doctoral thesis Richard Bliss compared students studying the two-model approach, i.e., creation and evolution, to students studying evolution only. Utilizing the pretest/posttest control group design, he randomly assigned students to each group. All the teachers involved in the experimental group classes were thoroughly instructed in the use of a two-model approach. These teachers were equally divided by personal belief in evolution and creation. The criterion-referenced pretest and posttest involved concepts and mechanisms related to origins of life. According to a Likert-type preference scale, the experimental and

control groups were identical before the experiment, but after the experiment, the group using the two-model approach had significantly more positive attitudes (.001 level) toward the subject of biology than the group using the one-model approach. Bliss found that the groups studying the two-model approach learned evolutionary data and arguments significantly better than did the students studying evolution only. From this study it would appear that students using a two-model approach learn about evolution more effectively and, in addition, learn about the creationist theories. Bliss concluded that,

Students seem to be more highly motivated and to learn more effectively when studying science from a two-model approach. They seem to have a better grasp of the data surrounding origins and they seem to be open-minded and willing to change their views when new data arrive. . . . The experimental group [using the two-model approach] seemed to develop more critical thinking habits than those who studied origins from an evolutionary model only.

The two-model approach has not only been used successfully at the elementary and high school levels but at the university level as well. At Michigan State University, undergraduate classes have been taught by a creationist professor and an evolutionist colleague.

The conflict in teaching about creation and evolution is not between science and religion, but between two theoretical models that harmonize with some religious views and are contradictory to others. From an extensive review of the legal literature, Wendell R. Bird concluded that the exclusive teaching of either theory in publicly supported schools results in abridgment of free exercise of religion, which is in violation of the First Amendment. If this position is correct, the exclusive presentation of the general theory of evolution is unconstitutional. Bird stresses that it is irrelevant whether the scientific model being taught is presented as "fact," the only viable theory, or one of many theories. The basic problem is exclusiveness and the pervasive presentation of one point of view.

Bird discusses three solutions: 1) exemption, 2) neutralization, 3) elimination. The first solution, that of exempting students from taking classes that teach evolution, and the third, that of eliminating creation/evolution issues and topics from the curriculum, Bird feels,

are clearly not in the best interests of either the students or the state. His conclusion is that neutralization is the most desirable solution. This can be achieved through the addition of one or more of the alternative theories of origins in courses that present the general theory of evolution. There are a number of states that have recognized this problem and have taken steps to prevent exclusive presentation of the general theory of evolution. These states include Ohio, Arizona, California, Oklahoma, Tennessee, Oregon, Georgia, Indiana, West Virginia, and Texas.

In addition, seminars on creationism have been offered at the University of Vermont, Oklahoma State University, San Diego State University, Northwestern University, Fresno State University, the University of Texas, Iowa State University, Virginia College of Graduate Studies, University of Wisconsin, and Bowling Green State University.

Textbooks and the Creation/Evolution Controversy

Many textbooks until recently typically presented a decidedly negative view of the creationist position, rarely discussing any possible merits to this viewpoint. At the same time, they took a decidedly positive view of the evolutionary position, rarely discussing any of its shortcomings. For example, the discussion in the textbook, *Biology*, by John Kimball includes an entire unit on evolution but presents only the evidence for evolution, almost totally ignoring the evidence purported to explain creationism.

A number of recently published textbooks, however, are endeavoring to include a more balanced version of the creation/evolution controversy. An example is the text, *Biology: An Inquiry Into the Nature of Life*, by Stanley Weinberg and Abraham Kalish. This is an example of a fairly balanced textbook.

As a result of Darwin's work, scientists generally came to reject special creation. Then and now, most biologists have accepted the theory of evolution through natural selection as the only reasonable explanation of the origin of the different kinds of living things.

But in recent years, a group of scientists and interested laymen have given renewed support to special creation. They call themselves *creationists*.

... In the 1920's, as a result of creationist activity, several states passed laws forbidding the teaching of evolution. ... [M]any of these state laws stayed on the books of several states.

In 1968 an Arkansas biology teacher, Susan Epperson, challenged the law in her state. She won her case in the U.S. Supreme Court. ... The Court declared all anti-evolution laws unconstitutional.

Since then the creationists have urged that evolution and creation be taught in schools on an equal footing. Leaving aside the religious basis, they assert that creation is adequately supported by scientific evidence. They claim that both creation and evolution are reasonable hypotheses, and students should be given an opportunity to study both. ...

The issue of creation vs. evolution concerns you not just as a biology student but as a citizen and prospective voter. You may have to help to decide what should be taught in the schools of your state and community. To decide wisely, consider both the evidence presented in this book and evidence that you may gather elsewhere.

In the teaching edition of this book, several references to creationist literature are given, including the Creation Research Society's textbook *Biology: A Search for Order in Complexity*.

Other recent textbooks have included a discussion of the creation/evolution controversy. For example, a college-level textbook on evolution, *The Science of Evolution* by William Stansfield, states:

[Creationists] acknowledge that fossils are the remains of prehistoric life forms, but do not accept the theory that some of them were ancestral to quite different forms living today. The creationist view may well be absolute truth. ... Both the creationist and the evolutionist have faith in their respective methodologies to provide answers to questions. However, the creationist can ... explain any phenomena by simply saying "God did it." This approach, though it may be perfectly correct in an absolute sense, does not foster further inquiry and is therefore intellectually emasculated. The [evolutionist] has no ready answer for most questions and must labor for solutions, and must continually monitor theories for their congruity with objective data. ...

When we come to the origin(s) of life, both creationists and evolutionists are forced into the role of speculators. Laboratory experiments conducted with presumed primitive earth atmospheric conditions ... have yielded small amounts of amino acids. ... Creationists have looked forward to the day when science may actually create a "living" thing from simple chemicals. They claim, and rightly so, that even if such a man-made life form could be created, this would not prove that natural

life forms were developed by a similar chemical evolutionary process. The scientist understands this and plods on testing theories.

In some instances, the evidence for evolution is meager and/or equivocal. Creationists focus attention on any tendency to acceptance of such evidence *carte blanche*. Perhaps the greatest contribution creationists are currently making to science is their recognition of "creeping dogmatism" in the science of evolution. Through their efforts, it is likely that science textbooks in California will have to retreat from such dogmatic statements as "Life began in the primordial sea at least three billion years ago." An acceptable revision of this concept might be "Most scientists have interpreted from the fossil record that life began in the primordial sea at estimates exceeding three billion years ago." This is as it should be. Absolutes have no place in science. The scientist should carefully avoid dogmatic statements, couching all conclusions in relativistic terms. When the scientist fails to do this, other members of the scientific community must be ready to correct such errors. If evolutionists do not keep their own house in order, the creationists stand ready to attack their veracity.

This same textbook refers to creationism at least a dozen times including creationist arguments involving the second law of thermodynamics.

There are a number of books that endeavor to present what is called "scientific creationism" in an acceptable manner for public schools. For example, a book titled *Scientific Creationism* takes the creationist position, avoiding political and religious arguments and utilizing solely scientific information. Although some critics feel that this information dwells on deficiencies in the evolution theory, deficiencies some evolutionists readily admit, there is some attempt to develop a theory of creationism by the use of models or theories that would predict certain events. The editor and 23 consulting authors of *Scientific Creationism* include 14 creationists who hold doctorates from nonsectarian universities in various fields of science; nine currently teach in nonsectarian universities.

There have been a number of biology textbooks written by creationists. The best known, *Biology: A Search for Order in Complexity*, is published by the Creation Research Society (2717 Cranbrook Rd., Ann Arbor, MI 48104). The 19 editors and authors of this book included at least 12 individuals who have doctorates in science from non-

sectarian schools. In addition, a guide to teaching both models in the public schools has been written by Henry Morris, *Introducing Scientific Creationism Into the Public Schools*.

To some extent more biology textbooks are now stressing that evolution is a theory or a hypothesis. For example, the widely used Biological Science Curriculum Study text series says, "The *theory* of evolution explains the variety of organisms but raises another important question: How does evolution come about? Two *hypotheses* to answer this question will be investigated" The same text further states, "*A scientific theory is always open to question and testing. It is subject to change if new factors call for a change. Some people have their own view of how the variety of life came about. But these views are not necessarily scientific theories. Some scientists have religious views that do not conflict with their understanding of science, for example, the French scientist-priest Teilhard de Chardin and the theologian-priest W. C. Pollard, former director of the Oak Ridge Atomic Facility.*"

A problem with many of these texts is that the discussion on evolution is entirely too brief, making unsupportable statements that are open to debate. Other statements might make the reader wonder about the total validity of the theory, such as this one from *Biological Science Curriculum Study (BSCS) Blue Version* (Boston: Houghton Mifflin): "Just one good bit of evidence that horses did exist at the same time as the dinosaurs would put the idea of evolution in serious trouble. The fact that evidence like this does not exist gives great confidence to the biologists that they have a sound theory." It would seem that if conclusive evidence showed that horses existed at the same time as dinosaurs, the evolutionists would be able to account for this within their theory.

Creationists generally feel that textbook discussions of evolution should be more complete, and they are quick to point out the inadequacies of evolution theory and stress that it *is* a theory (which many texts do). Creationist literature itself spends some time discussing the shortcomings of the creationist theory, which supporters of creationism admit does not fully explain the data. Obviously, creationists

feel that their views more fully explain the data than does evolution, but neither theory adequately explains all of the data.

The creationist and the evolutionist generally do not differ about the data but they do disagree on the *interpretation* of the data. For example, an evolutionist would see a similarity in bone structure as evidence of a common evolutionary origin whereas a creationist would see it as evidence of a common designer.

Summary

The creation/evolution controversy is an issue where there is typically "more heat than light" and this tends to be true for both sides. I have argued that teachers have a responsibility to present accurately all sides of controversial issues. The fact that there are well-informed scientists on each side, even though one side may be a minority view, argues for the position that both sides can have some validity. On the other hand, teachers have an obligation to present accurately what is currently the most widely accepted theory, which in this case is evolution. However, the fact that one theory is more accepted does not argue that other theories do not have some merit and support from both scientific evidence and from members of the scientific community.

There are other more cogent reasons for presenting a two-model approach. Foremost of these is a pedagogical one, i.e., teaching by contrasts is an effective way to present information and concepts. In addition, it is important to stress that there is much controversy and opinion in the field of origins (as there is in many other fields of science today). It would be inaccurate to present a theory, even if the theory is well accepted, as "scientific fact" and not without its difficulties.

In the study of origins, it is important to discuss the empirical method and the limits of demonstrating reality with this method. When we are dealing with happenings in the geological past, it should be stressed that understanding what happened in the past is always conjecture—even if the evidence seems very strong for a certain interpretation. In dealing with evolution, we are dealing with events that

occurred a long time in the past and, as such, they are open to interpretation.

The schools should be forums for debate and discussion of all topics. To exclude discussion of life's origins because they involve religious views does not do justice to the educational enterprise. Some feel that anything related to religion and politics should not be discussed because it arouses emotions and feelings and cannot always be discussed rationally. I would argue that these are the important matters of life and they should indeed be studied, discussed, and debated in the neutral forum of a classroom and under the guidance of a teacher who can remain objective.

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